Evaluation of Soil Health Indicators for Sustainable Intensification of Maize-based Cropping Systems in Semi-arid Tanzania

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Abstract

Improved management of land is critical to overcoming soil related constraints to sustainable food production in degraded soils. We characterized soils and land use patterns in Kongwa and Kiteto districts to assess fertility status and drivers of land degradation so as to develop integrated land management options for sustainable intensification. Two approaches that complimented each other were used. The first was the Land degradation Surveillance Framework (LDSF), which combines ground-sampling schemes and infrared spectroscopy to assess soil indicators needed to identify key land constraints for crops production and target interventions. Remote sensing and GIS techniques were used to generate clusters of plots within a 10x10m block (sentinel) in Njoro village. The second approach was the sampling scheme in experimental sites where fertilizer trials were established to confirm LSDF predictions. Standard mapping techniques were used to open, describe, and sample soils from profile pits in 5 villages and from random points in the plots. Soil data (nutrients, carbon levels, infiltration rates and types) and ecological data (land use types tree cover and density etc.) were collected for this study. Results showed that soils belonged to Lixosols (Laikala, Mlali and Molet Villages), Luvisols (Manyusi, Njoro and Laikala villages) and Vertisol (Mlali) orders. Generally soils in these villages had poor to moderate fertility, especially for CEC (7.3-8.7 $Cmol^{(+)}$/kg soil) and exchangeable bases. Soil total nitrogen (0.04-0.08%), extractable phosphorus (4.6-7.2 mg/kg) and organic carbon (0.5-0.72%) ranged from very low to low. The highest values noted for Luvisols in Manyusi while lowest values were found in highly degraded Luxisols in Laikala, Molet, and Mlali villages. Aridity indices revealed that Moleti has steppe characteristics while other villages are semi-arid with very short growing periods of 2-3 months. Only 9% of land in the Njoro sentinel is under cultivation and the rest is grazing land and forests (Acacia woodlands). Livestock carrying capacity exceeded the optimum and tree cover was low, being 84.3 stems ha^{-1} compared to 268.9 stems ha^{-1} for shrubs. These factors would be the major reasons for high land degradation noted in this study. To sustain crop production, soils will require inputs of fertilizers (especially nitrogen and phosphorus) and manure to replenish nutrients and build OC. Additionally integrating leguminous trees/shrubs in agricultural landscapes would enhance vegetation cover and carrying capacity of grazing lands in addition to improving soil health and land productivity.

Key words: Carrying Capacity, Livestock, LDSF, Land management, Soil health